GRADE 12 DIPLOMA EXAMINATION

Physics 30

June 1984

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 55 multiple-choice questions each with a value of 1 mark.

PART B: Four written-response questions for a total of 15 marks.

A physics data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. Use an HB pencil only.

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. Mathematics

Answer Sheet

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully and write your answer in the space provided in the examination booklet.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET.

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JUNE 1984

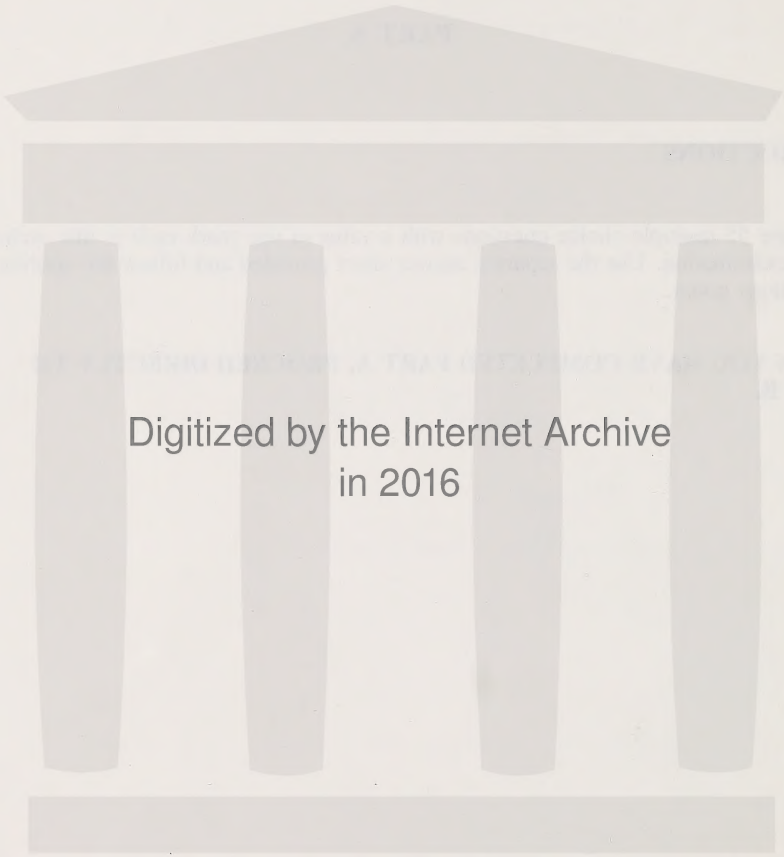
PART A

INSTRUCTIONS

There are 55 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B.

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

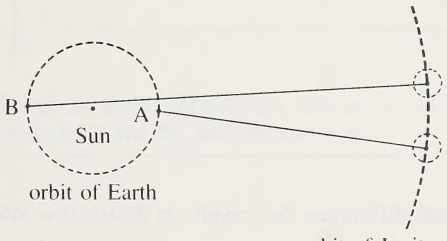


1. Light going from air to glass at an angle of 45° to the normal will

   A. decrease its speed and wavelength
   B. decrease its wavelength and frequency
   C. increase its frequency and maintain its speed
   D. increase its wavelength and maintain its frequency

Use the following information to answer question 2.

The eclipse of Jupiter's moon from position B is seen to occur 22 min later than from position A.



2. Given that the diameter of the Earth's orbit is 3.0×10^{11} m, the speed of light as Huygens would have calculated it is

   A. 1.4×10^{8} m/s
   B. 1.9×10^{8} m/s
   C. 2.3×10^{8} m/s
   D. 3.0×10^{8} m/s

---

3. In a double-slit experiment, light passes through two slits that are 0.020 cm apart. Two consecutive dark fringes are formed 0.60 cm apart when a screen is placed 3.0 m from the slits. The wavelength of the light is

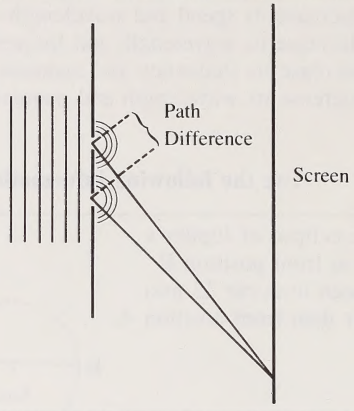
   A. 1.0×10^{-7} m
   B. 2.0×10^{-7} m
   C. 4.0×10^{-7} m
   D. 8.0×10^{-7} m

4. The period of vibration for a 4.0×10^{-7} m light source is

   A. 1.3×10^{-15} s
   B. 3.0×10^{-8} s
   C. 1.2×10^{2} s
   D. 7.5×10^{14} s

Use the following information to answer question 5.

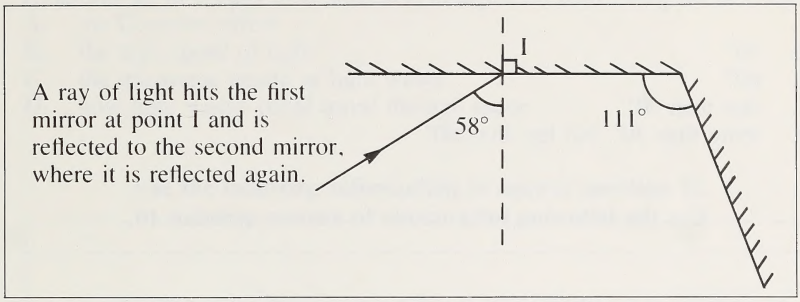
Parallel light waves of a single wavelength illuminate two narrow slits. The result is an interference pattern on the screen.



5. The path difference that results in destructive interference (minima) is

A. $\frac{1}{2}\lambda$
B. λ
C. 2λ
D. 3λ

Use the following information to answer question 6.



6. If the angle of incidence is 58° and the angle between the mirrors is 111°, then the angle between the final reflected ray and the second mirror is

A. 53°
B. 37°
C. 32°
D. 11°

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7. To gather data for measuring the speed of light, Römer observed

A. lantern flashes
B. Jupiter's moons
C. light radiated from the sun
D. light reflected by an eight-sided mirror

8. A red light beam passes through two transparent plates of glass with no apparent loss of brightness. When one of the plates is rotated 90°, however, no light gets through. This observation can be explained by the concept of

A. reflection
B. refraction
C. interference
D. polarization

9. If an incident light ray in air strikes a glass plate, making an angle of 60° with respect to the plate, then the angle of reflection with respect to the normal is

A. 30°
B. 60°
C. less than 30°
D. more than 30°, but less than 60°

Use the following information to answer question 10.

In addition to its other properties, it has been found that light

I travels in straight lines
II has wave characteristics
III has particle characteristics
IV consists of many colors

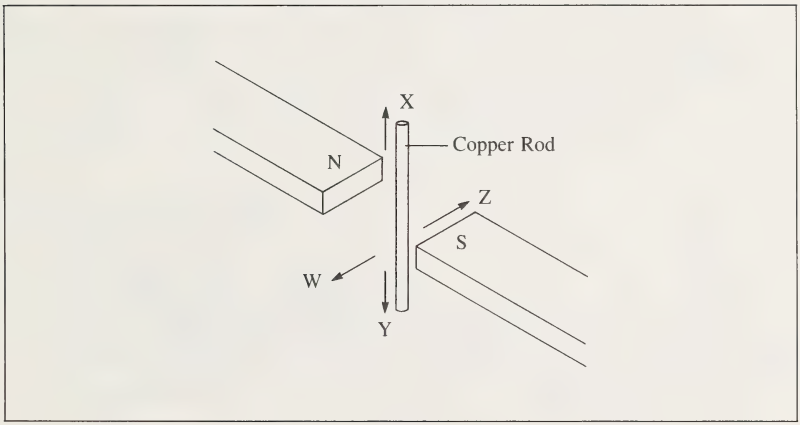
10. Which of these properties is common to all theories about light?

A. I
B. II
C. III
D. IV

11. It was thought that an ether was necessary to explain

A. the Compton effect
B. the high speed of light
C. the transverse nature of light waves
D. how light waves could travel through space

Use the following information to answer question 12.



12. When the rod is stationary in the magnetic field, electrons in the rod will

A. move in the direction of W
B. move in the direction of X
C. move in the direction of Y
D. not move in any direction

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13. The units of electric potential difference are the same as the units of

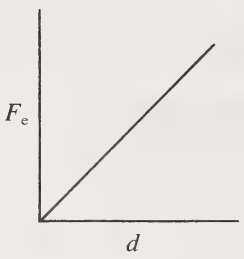
A. current divided by time
B. force divided by charge
C. energy divided by charge
D. work divided by time

14. The internal resistance of a 350 W hairdryer operating on a 120 V circuit is

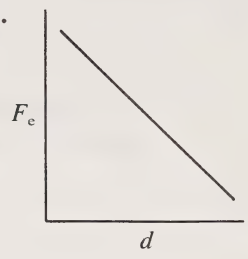
A. $4.2 \times 10^{4}\ \Omega$
B. $4.1 \times 10^{1}\ \Omega$
C. $3.4 \times 10^{-1}\ \Omega$
D. $2.4 \times 10^{-2}\ \Omega$

15. The graph that is consistent with Coulomb's discoveries about the relationship between electric force (F_e) and distance (d) between two charged objects is

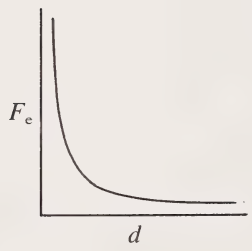
A.



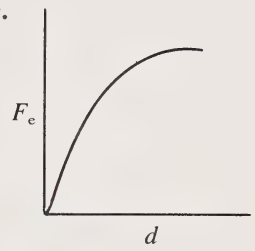
B.



C.



D.



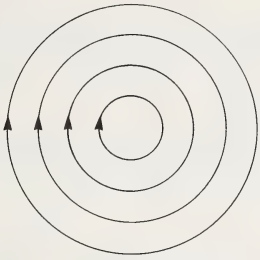
16. For a metal sphere to become positively charged by induction, it must have a

A. positive charge brought in contact with it
B. negative charge brought in contact with it
C. positive charge brought near while the sphere is briefly grounded
D. negative charge brought near while the sphere is briefly grounded

17. Two charged objects, X and Y, separated by 0.40 m, exert a force of 4.0×10^{-6} N on each other. If the distance between X and Y were doubled, the electric force would be

A. 1.6×10^{-5} N
B. 8.0×10^{-6} N
C. 2.0×10^{-6} N
D. 1.0×10^{-6} N

Use the following information to answer question 18.



The diagram represents a field pattern.

18. The field represented is the

A. electric field around a point charge
B. electric field above a charged plate
C. magnetic field around a straight current-carrying wire
D. magnetic field at the centre of a circular loop carrying an electric current

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19. The force experienced by a charged particle moving in a magnetic field is independent of

A. its mass
B. its charge
C. its velocity
D. the magnetic field strength

20. A 4.0×10^{-6} C charge with a mass of 3.0 g experiences a force of 8.0 N while under the influence of an electric field. What is the intensity of the electric field (assuming there are negligible gravitational forces)?

A. 2.0×10^{6} N/C
B. 4.8×10^{6} N/C
C. 6.0×10^{6} N/C
D. 1.6×10^{7} N/C

21. Millikan decided that the lowest charge he found was a one-electron charge because

A. this value agreed with that obtained by applying the equation $qE = mg$
B. all other values of charge were multiples of this lower value
C. when the mass was related to the force of gravity, this value was the minimum charge required
D. this value agreed with that obtained using Thomson's results for charge-to-mass ratio for cathode-ray particles

22. If a positively charged test body is placed in an electric field that is directed downward, the direction of the force on the test body is

A. up
B. down
C. left
D. right

23. Two charged objects, each with a mass of 2.0×10^{-9} kg, accelerate in an electrical field of 4.0×10^{6} N/C. If the acceleration of one object is -3.2×10^{-3} m/s^2 and the acceleration of the other object is -1.92×10^{-3} m/s^2, the charges differ by

A. $8e$
B. $6e$
C. $4e$
D. $2e$

24. The electroscope is an instrument used to

A. detect the presence and nature of an electric charge
B. detect the presence and direction of a small electric current
C. measure the potential difference across two points of a circuit
D. measure the magnitude of the electric current through a circuit

Use the following information to answer question 25.

An electric current can be induced in a coil of wire when a magnet is moved near it. Possible variables that may affect the magnitude of the current are:

I the strength of the magnet
II the number of turns in the coil
III the speed of relative movement between magnet and coil

25. The magnitude of the induced current is dependent on variables

A. I and II only
B. II and III only
C. I and III only
D. I, II, and III

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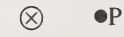
26. Evidence suggests that electromagnetic radiation originates from

A. oscillating neutrons
B. vibrating protons
C. accelerating charges
D. orbiting electrons

Use the following information to answer question 27.

The symbol ⊗ in the diagram represents a positive current-carrying wire with current going into the page.



27. The direction of the magnetic field at point P is

A. left
B. right
C. up
D. down

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28. Maxwell proposed that a changing electric field generates

A. a constant magnetic field
B. a parallel magnetic field
C. a changing magnetic field
D. an electric charge

29. In an experiment similar to that done by Hertz, sparks are produced at a frequency of 4.0×10^{10} Hz. The wavelength of the microwave radiation produced is

A. 1.3×10^{-4} m
B. 7.5×10^{-3} m
C. 1.2×10^{1} m
D. 3.0×10^{8} m

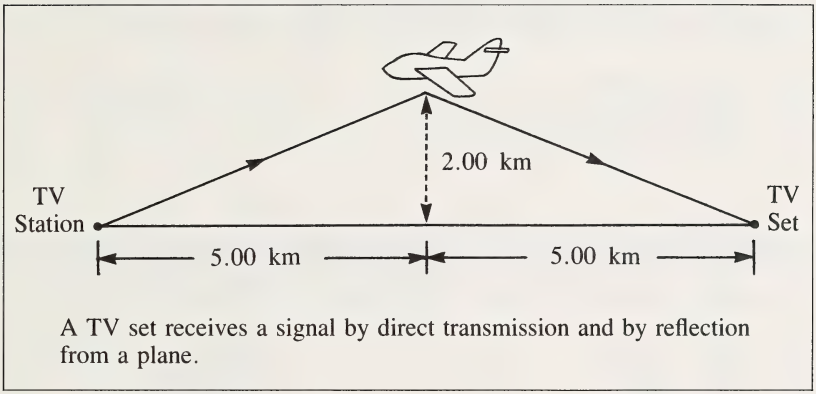
30. Infra-red radiation can penetrate atmospheric conditions that block visible light because

A. long wavelengths scatter less than short wavelengths
B. short wavelengths scatter less than long wavelengths
C. infra-red rays have a much higher frequency than visible light
D. infra-red rays travel faster and therefore penetrate further

31. X-rays are classified as wave phenomena because they

A. are diffracted by atomic crystals
B. are produced by Crookes' tubes
C. ionize air molecules
D. penetrate many solids

Use the following information to answer question 32.



A TV set receives a signal by direct transmission and by reflection from a plane.

32. The reflected signal is received in

A. 7.18×10^{-5} s
B. 3.59×10^{-5} s
C. 3.33×10^{-5} s
D. 1.80×10^{-5} s

---

33. If gamma radiation has a period of 1.0×10^{-24} s, its wavelength

A. is 3.0×10^{32} m
B. is 3.0×10^{-16} m
C. is 3.0×10^{-18} m
D. cannot be calculated

34. A radar beam reflected off a distant object takes 2.0×10^{-3} s from transmission to reception. The distance between the transmitter and the object is

A. 3.0×10^{5} m
B. 6.0×10^{5} m
C. 1.5×10^{11} m
D. 6.7×10^{11} m

35. An FM radio station's broadcast frequency is 90.3 MHz. What is the wavelength of the station's radio waves?

A. 3.01×10^{-1} m
B. 3.32 m
C. 3.32×10^{6} m
D. 2.71×10^{10} m

36. Maxwell's synthesis of optics and electromagnetism was based on the discovery that light and electromagnetic waves

A. can be reflected
B. have the same frequency range
C. have very nearly the same speed
D. travel in straight lines

37. An electron moves at 4.0×10^{6} m/s perpendicularly through a magnetic field of 1.6×10^{-3} T. The radius of curvature that the electron follows while in the field is

A. 7.0×10^{-1} m
B. 4.4×10^{-1} m
C. 1.4×10^{-2} m
D. 2.3×10^{-22} m

38. Sodium used in a photoelectric cell is irradiated by EM radiation of frequency 6.2×10^{15} Hz. If the threshold frequency for sodium is 5.6×10^{14} Hz, then the maximum E_k of the photoelectrons produced is

A. 1.1×10^{-19} J
B. 4.1×10^{-18} J
C. 3.7×10^{-18} J
D. 5.6×10^{-15} J

39. In an electrolysis experiment, a current of x amperes flowing for y seconds produces 30 g of zinc. If a current of $3x$ is used for $y/2$ seconds, the mass of zinc produced will be

A. 20 g
B. 45 g
C. 90 g
D. 180 g

40. In Millikan's oil drop experiment, the electrical force was balanced by the

A. gravitational force
B. magnetic force
C. centripetal force
D. nuclear force

41. Dalton's assumption that matter is made up of small indivisible particles led to his explanation of the

A. periodic table
B. difference between metals and non-metals
C. law of conservation of mass
D. law of definite proportions

42. In the electrolysis of a solution containing Cu^{2+} ions, if a current of 1.5 A flows for 5.0 min, the mass of copper deposited is

A. 2.5×10^{-3} g
B. 4.9×10^{-3} g
C. 1.5×10^{-1} g
D. 3.0×10^{-1} g

43. A charged particle used in an experiment with Thomson's apparatus enters a magnetic field of 0.20 T at a speed of 5.0×10^{5} m/s and is curved into a circular orbit with a 5.0 cm radius. The charge-to-mass ratio of this particle is

A. 1.0×10^{6} C/kg
B. 2.5×10^{6} C/kg
C. 2.5×10^{7} C/kg
D. 5.0×10^{7} C/kg

44. In which fields will a beam of electrons experience a force?

A. Electric and magnetic only
B. Electric and gravitational only
C. Magnetic and gravitational only
D. Electric, magnetic, and gravitational

45. The maximum frequency of X-rays emitted from an electron tube operating at a potential difference of 4.0×10^{4} V would be

A. 1.0×10^{19} Hz
B. 9.7×10^{18} Hz
C. 4.3×10^{17} Hz
D. 1.6×10^{17} Hz

46. The concept of the nuclear atom is supported by the results of

A. cathode ray experiments
B. oil drop experiments
C. photoelectric experiments
D. scattering experiments

47. Bohr's model of the atom accounted for the

A. spectral lines of hydrogen
B. spectra of helium and lithium
C. effect of magnetic fields on the emission spectra of elements
D. splitting of spectral lines when a sample of the element was placed in an electric field

48. The Compton effect illustrates that photons have

A. neither mass nor momentum
B. neither momentum nor wavelength
C. both wavelength and amplitude
D. both momentum and kinetic energy

49. If all the mass present in 2.0 kg of coal were converted completely into energy, the amount of energy produced would be

A. 9.0×10^{8} J
B. 1.8×10^{9} J
C. 9.0×10^{16} J
D. 1.8×10^{17} J

50. An object with rest mass m_0, travelling at 1.80×10^{8} m/s, would have a relativistic mass of

A. $1.67m_0$
B. $1.25m_0$
C. $0.600m_0$
D. $0.360m_0$

51. Light is observed to behave

A. as waves at all times
B. as wave-particles at all times
C. as particles at all times
D. sometimes as waves, sometimes as particles

52. The de Broglie wavelength for an electron moving with a velocity of 2.0×10^{7} m/s is

A. 2.7×10^{10} m
B. 3.6×10^{-11} m
C. 1.8×10^{-23} m
D. 4.6×10^{-38} m

53. The total mass of a moving object is the sum of

A. $m_0 + \Delta m$
B. $m_0 + m$
C. $m + \Delta m$
D. $m + E/c^2$

54. Schrödinger sought to express mathematically the wave-particle duality of matter. His equation

A. confirms the work of Maxwell
B. contradicts the Balmer equation
C. provides a visual picture of the atom
D. defines the wave properties of electrons

55. If the momentum of a photon is 2.2×10^{-38} kg•m/s, its frequency is

A. 6.6×10^{30} Hz
B. 3.0×10^{4} Hz
C. 1.0×10^{4} Hz
D. 6.6×10^{-30} Hz

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Show all pertinent calculations and formulas, and give your answers to the correct number of significant figures.

TOTAL MARKS: 15

START PART B IMMEDIATELY

(USE FOR ROUGH WORK ONLY)

1. In a variation on Young's double-slit experiment, students attempt to determine the effect of slit separation and source wavelength on the distance between consecutive bright lines of the resulting interference pattern.

a. A DEPENDENT (responding) variable in this experiment is

(1 mark) _____ .

b. An INDEPENDENT (manipulated) variable in this experiment is

(1 mark) _____ .

c. Name one other variable that could be investigated by the students as having a direct effect on the distance between consecutive bright lines.

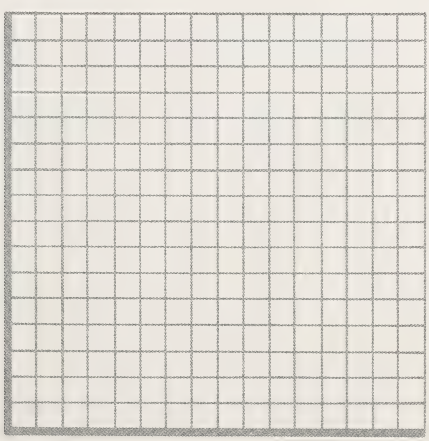
(1 mark) _____

As a result of their experiment, the students recorded the following data on the relationship between wavelength and distance between consecutive bright lines.

Wavelength (m)	**Distance Between Consecutive Bright Lines, Δx (m)**
5.0×10^{-7}	5.0×10^{-3}
5.4×10^{-7}	5.5×10^{-3}
5.8×10^{-7}	5.7×10^{-3}
6.0×10^{-7}	6.0×10^{-3}
6.2×10^{-7}	6.2×10^{-3}

d. On the grid provided, show the relationship between the two variables. Be sure to label both axes.

(2 marks)



(USE FOR ROUGH WORK ONLY)

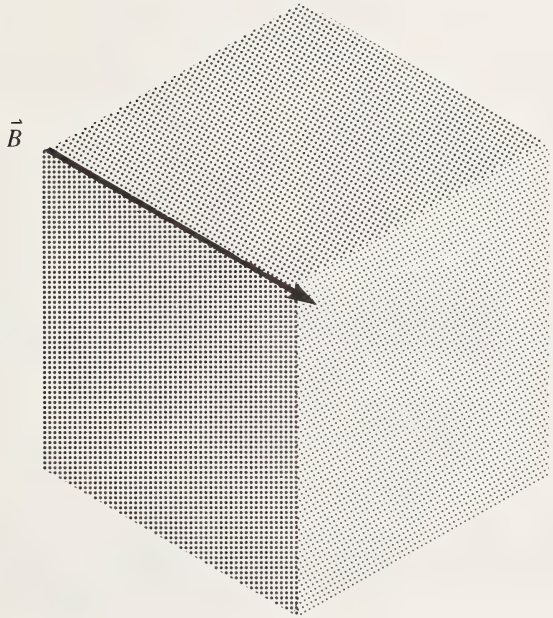
2. What is the relativistic mass of a proton with a kinetic energy of 2.00×10^2 MeV? Be sure to show ALL your calculations and the formulas that you use to solve this problem. Your answer must be expressed to the appropriate number of significant figures.

(3 marks)

(USE FOR ROUGH WORK ONLY)

3. A proton enters a uniform magnetic field at an angle of 90° to the field. The proton is travelling at a speed of 2.0×10^5 m/s, and the strength of the magnetic field is 1.4 T.

(2 marks) **a.** On the three-dimensional grid below, draw a vector diagram of the situation described above, indicating vectors for $\vec{v}$ and $\vec{F}$.



(1 mark) **b.** What is the magnitude of the force experienced by the proton?

_____

(1 mark) **c.** What is the direction of the force experienced by the proton?

_____

(USE FOR ROUGH WORK ONLY)

4. The masses of several boxes containing identical items were determined. Each of the boxes was the same mass. The number of items in any given box was unknown.

The following results were obtained.

Box Number	Mass of Box and Contents (g)
1	1.05
2	2.10
3	1.25
4	2.65
5	3.10
6	6.55
7	3.25
8	4.65
9	4.20
10	1.95

(1 mark) **a.** Without knowing the mass of the box or the number of items in any box, what may be inferred concerning the mass of a single item?

_____

_____

(1 mark) **b.** The activity described above is analogous to a historic experiment related to one of the elementary particles. Name the physicist associated with the experiment.

_____

(1 mark) **c.** State one conclusion regarding one of the elementary particles that was derived from the historic experiment.

_____

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

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M1 M2 M3

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(LAST NAME) (FIRST NAME)

NAME:

Y M D

DATE OF BIRTH: SEX:

SCHOOL CODE: SCHOOL: _____

CITY: _____

NAME OF EXAMINATION: _____

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